CHAPTER 4

AIR QUALITY CONTROL AND MONITORING EQUIPMENT

4-1. General.

Refer to TM 5-815-1 for a detailed description of the major air quality control devices available for boiler plant emissions control. Air pollution control guidelines are discussed in AR 42049.

4-2. Particulate control systems.

The types of particulate control systems which are commonly used are mechanical cyclone collectors, fabric filter baghouses and electrostatic precipitators.

4-3. Flue gas desulfurization systems.

The dry and wet types of FGD systems are commonly used to remove sulfur oxides from the boiler flue gas.

4-4. Nitrogen Oxide (NO_x) control systems.

Two types of systems available for NO_x emissions reduction are selective catalytic reduction (SCR) and selective noncatalytic reduction (SNCR). SCR systems require periodic replacement of the catalyst. SNOR removal efficiency is maintained only within a narrow temperature range.

4-5. Air monitoring equipment.

a. General. Federal regulations require new sources to obtain and maintain acid rain permits. A permit is good for five years and must be renewed. Emission allowances are required to emit sulfur dioxide. Pollutants must be monitored to verify compliance with the acid rain program. Reported values include SO_2 (lb/hr), NO_x (lb/MB), CO_2 (lb/hr), excess opacity (percent), and heat input (MB). Measurement options are available to gas/oil fired units, depending upon the type or category of gas/oil unit. Exemptions from acid rain permit requirements including exemptions from continuous emissions monitoring (CEMS) are available to certain types and sizes of emitters by petition. A thorough investigation of local, state, and federal regulations is required for each new source.

b. CEMS components. CEMS include four major components or subsystems. Gas monitors measure the concentration of pollutants at a particular point in the flue gas stream. Flow monitors measure flue gas flow and fuel flow monitors measure natural gas and fuel oil flow rate. Opacity monitors indicate the emission of particulate matter from the stack. The data acquisition system (DAS) stores monitored information, performs necessary calculations and generates the required reports.

c. Gas monitors. Gas monitors can be classified as either in situ or extractive.

(1) In situ analyzers are attached directly to the probe on the stack or breeching. Access for routine maintenance is required and personnel weather protection may also be desirable for outdoor installations depending upon the climate. In situ monitors relay information to the DAS using 4 to 20 mA signals.

(2) Extractive monitors pull samples from the flue gas stream using stack or breeching probes. The flue gas sample is then transported to the cabinet mounted analyzer located on the plant floor or ground level as required. This cabinet is placed to provide convenient access for operation and maintenance. The interior of the cabinet can also include any necessary heating, air conditioning or humidity control. Extractive systems are further classified as either wet, dry or dilution. Since raw samples contain SO_2 and moisture, ambient cooling of wet samples will cause condensation of sulfuric acid. For longevity of the equipment wet sample tubes must be heated to avoid acid corrosion. Removal of water from the sample using a cooler provides a dry sample which no longer requires heating. These systems are called dry extractive. Dilution extractive systems use clean dry air to dilute the sample gas in the probe from between 50 to 200 times. This diluted sample eliminates the need for heat traced sample lines, pumps, filters or dryers. Analyzers are readily available to accurately and reliably measure diluted pollutant concentrations.

d. Flue gas flow monitors. Monitoring of flue gas flow is sometimes required. In these cases flue gas flow is used along with the primary measured value to calculate the reported value. Three types of flue gas flow monitoring systems that have been used include ultrasonic monitors, thermal monitors and differential pressure monitors.

(1) *Ultrasonic flow rate monitors.* Ultrasonic flow monitors consist of two ultrasonic transducers mounted at different elevations and on opposite sides of the stack. This type of monitor measures the time required for an ultrasonic pulse to travel from the downstream transducer to the upstream transducer. The speed of sound in the flue gas stream and the flue gas stream temperature are

determined from the average of these two measurements. The velocity of the flue gas stream is determined from the difference between the measurements. An input signal from the plant barometer can be provided so that flow rate can be calculated in standard cubic feet per minute. Automatic zero checks of ultrasonic flow monitors are conducted by sending successive pulses in the same direction. Span checks are conducted by again firing successive pulses in the same direction, but with a time delay between the pulses which represents a specific flue gas flow velocity.

(2) *Thermal flow rate monitors.* Thermal flow monitors depend on temperature measurements and thermal properties of the flue gas. There are two types of thermal measurement. One type measures the temperature difference between two similar resistance temperature devices (RTD), one is heated at a constant rate and the other is unheated. The temperature difference will be a function of the velocity of the flue gas. The higher the velocity, the greater the cooling effect, and hence the smaller the temperature difference. The other type of thermal probe varies the current to the heated element as necessary to maintain a constant temperature difference. The higher the velocity of the flue gas, the greater the heat rate required to maintain the temperature differential. Zero and span checks of these devices require their removal from service. Techniques for conducting automatic daily calibration drift tests have not yet been developed.

(3) *Differential pressure flow monitors.* Differential pressure flow monitors use the pitot tube principle to measure the flow. A pitot tube is a device which measures both the static pressure and the impact pressure created by the flue gas. The square root of the difference in these two pressures is a function of the gas velocity. Types include single point and across-the-duct averaging. One version of the averaging pitot probe has a diamond shaped cross-section and multiple impact and static pressure taps along the length of the probe. Standard differential pressure transmitters are used to sense the difference between the static and total pressure. These devices are simple and use standard pressure transmitters. In high particulate applications, a purge system may be needed to keep the pitot pressure taps clear. Zero checks are accomplished by pneumatically connecting the two sides of the pressure transmitter. These checks can easily be automated for daily zero drift checks. Span checks can be performed by using a water manometer. This type of span procedure is more difficult to automate.

e. Opacity monitors. Opacity monitors use the principle of transmissometry to indicate the level of particulate emissions. A beam of light is projected across the flue gas stream. A measurement detector registers variations in the light transmittance caused by the amount of particulate in the flue gas.

f. Data acquisition systems. Data acquisition systems (DAS) typically consist of personal computers (PC). A typical system includes a central processing unit (CPU), hard disk drive, a floppy disk drive, a keyboard, a cathode ray tube (CRT) or TV screen and a printer. Serial ports and required software are included to accept the input signals from the monitoring equipment. The hard disk drive provides magnetic storage of data and allows quick access for rapid calculation. The floppy disk drive allows storage of years of historical data in more than one remote location which decreases the risk of loosing this information while at the same time provides rapid regeneration of past reports. The printer provides hard copy of all data while the keyboard and CRT allow operator interface. The DAS performs several tasks. Signals from the monitors must be interpreted and stored. This data is stored in the form of ASCII files. A continuous readout of emissions in the required measurement units is produced. The DAS performs monitor calibration errors and bias adjustments. Missing data procedures are also computed and recorded by the DAS. Required reports are also generated by the DAS.

g. Regulatory requirements. The regulations include several specific equipment requirements. These include span values, calibration capabilities, calibration error limits, relative accuracy, bias limits, calibration gas quality and cycle response time.

(1) Proper monitor location for specific installations is essential. The final location must be representative of total emissions, must pass the relative accuracy (RA) test and must meet point/path requirements as outlined in the regulations. Location has to provide representative flow over all operating conditions. This requires that the velocity at sample point be representative of the average velocity over the cross section. Emission rate in terms of lb/MB must reflect actual emissions. Monitor location must also represent actual pollutant concentration. Location has to minimize the effects of condensation, fouling and other adverse conditions. Tests are also required to determine the acceptability of the location and to also determine the number and location of flow monitor points.

(2) There are specific reporting requirements that have to be addressed. Notification must be given to governing federal, state and local agencies prior to certification and recertification tests. A

monitoring plan must be established. Applications have to be submitted for certification and recertification tests. Quarterly reports and opacity reports are also mandatory.

(3) The monitoring plan although not part of the GEMS specifications has several elements that are common to both. Monitoring plans include pre-certification information, unit specific information, schematic stack diagrams, stack and duct engineering information, monitor locations, monitoring component identification table, DAS table and emissions formula table.

(4) Records have to be maintained for at least three years. Record keeping includes current monitoring plan, quality plan and hourly operating data. Hourly data must include date, hour, unit operating time, integrated hourly gross unit load, operating load range and total heat input in MMBtu.

(5) The certification tests have to be successfully executed on time. These tests include a 7 day calibration error test for gases and flow, a linearity check, cycle time/response time test, relative accuracy test and bias test. Guidelines clearly outline whether or not recertification tests are required when changes have been made to equipment, location or the DAS.

(6) Quality assurance and quality control procedures must be developed into a well defined program which includes calibration error testing and linearity checking procedures, calibration and linearity adjustments, preventative maintenance auditing procedures or relative accuracy test audit (RATA). Calibration error tests have to be performed on a daily basis. SO_2 and NO_x monitors must be challenged by zero level and high level calibration gases. The measured values must be within 2.5 percent of the cal gas value. If the span is less than 200 ppm then the values must be within 5 ppm. CO_2 or 02 monitors also have to be challenged by zero level and high level calibration gases. For these monitors the measured value must be within 0.5 percent of the cal gas value. Flow monitors are required to zero at 20, 50 and 70 percent of span. The measured values have to be within 3 percent of the referenced value. Linearity checks are required quarterly. These checks must use dedicated low, mid and high level cal gases. Measured values must be within 5 percent of the cal gas value. Average difference among three nonconsecutive checks with each cal gas must be less than or equal to 5 ppm for SO_2 and NO_x or less than or equal to 0.5 percent of CO_2 or 0_2.

(7) Several daily adjustments are required. Error adjustments on gas and flow monitors are required daily. Recalibration must then be performed after each adjustment. A flow monitor interference check is necessary. This includes sample sensing line port pluggage and RTD/transceiver malfunction. An out of control period is when calibration error exceeds two times the calibration error limit or when flow fails interference check. Data recording must include unadjusted values and magnitude of adjustment.

(8) Quarterly adjustments are also required. Linearity must be checked on a quarterly basis when no adjustments are made. Leak checks are required for differential pressure monitors. An out of control period is when linearity exceeds limit on any test run or when a flow leak is detected.

(9) Preventive maintenance procedures must be in writing, including equipment manufacturer's recommendations. A schedule for the implementation of these procedures has to be maintained. An inventory of spare parts is also required.

(10) A relative accuracy test audit (RATA) is required semi-annually unless accuracy is better than 7.5 percent. The RATA has to be performed during a 7 day period. A minimum of 9 sets of reference method test data are needed. One set of data consists of a 3 point traverse at 0.4, 1.2 and 2.0 meters from the wall of the stack or duct. The gas sample must be analyzed for concentrations or flow using the reference methods. Calculations must include determinations of the mean, standard deviation, confidence coefficient and bias. A flow test is required.